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ELECTRONICS SUB-SYSTEM FOR A SOLAR EUV SPECTROMETER.(U)

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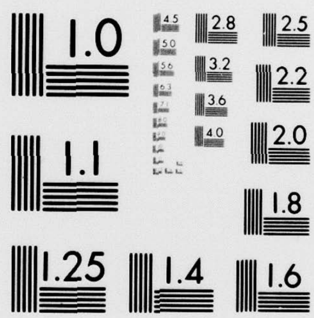
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ELECTRONICS SUB-SYSTEM FOR A SOLAR EUV SPECTROMETER

Robert S. Hills

TRI-CON ASSOCIATES, INC.
765 Concord Avenue
Cambridge, Massachusetts 02138

30 October 1979

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report describes the design, fabrication, and launch of an electronics sub-system for a grazing incidence solar spectrometer for sounding rockets.

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1. INTRODUCTION

This report covers the design, fabrication, checkout and launch of the electronics sub-system for a grazing incidence, double-deck EUV scanning spectrometer.

The personnel who worked on this contract were Robert S. Hills, Norbert F. Robertie, Timothy A. Doyle and Arthur A. Dean.

An electronics system similar to the system described in this report was built for Spectrometer RM 60B under a subcontract from Comstock & Wescott (Contract F19628-73-C-0253).

2. ELECTRONICS

2.1 General

A separate electronics sub-system was built for each deck of the instrument. Each sub-system included a high voltage power supply, a divider board, a pulse amplifier for each of the four detectors, and three logic cards, one of which mounted a dual plus and minus fifteen volt power supply.

The three logic cards of each deck were mounted in a single electronics box. Other than the common box and a common electrical connector, the electronics of each deck were entirely separate.

The current pulses from the four detectors were processed by the instrument electronics. The pulses were counted and the count converted to a binary coded decimal number. The magnitude of the number is a function of the radiation intensity. The electronics also controlled the wavelength scan drive motor and generated a decimal number representing the wavelenth of the radiation being processed by the detector electronics.

Each of the above decimal numbers, or words, consisted of four decimal digits and each digit was comprised of four binary coded decimal bits. In addition, a 16 bit synchronization word was generated which facilitated the computer data reduction.

The six words described above (sync word, scan position word, and four detector words) made up a PCM data frame consisting of 96 bits (6 words of 16 bits each). A separate PCM data channel was used for each deck.

The frame rate was the same as the scan stepping rate of 10 per second and was synchronized with it so that the scanner would move to the next position at the beginning of the PCM frame (bit 1 of sync word). A timing diagram of the PCM data format and logic waveforms is given in Figure 1. Note that the first two bits of the PCM data are of greater amplitude than the remaining bits. This permitted the start of each frame to be detected by amplitude discrimination, in lieu of digital techniques requiring comparison of 16 bits. Thus, the ground support equipment was greatly simplified to work reliably on clear strong signals present in the laboratory and prior to launch. The digital sync word was used by the computer for reducing actual flight data.

For flight the PCM data were brought through the interface connector and were used to modulate IRIG channels 18 and 19 subcarrier oscillators in an S-band telemetry deck. These subcarrier channels have a nominal rise time of 330 and 250 microseconds which is more than adequate for transmission of the PCM signal which has a non-return-to-zero form and a bit width of 1041.6 microseconds.

In addition to the PCM data signals containing the detector photon counts and wavelength information, three voltage monitors for each deck were also brought out to the interface connector and were commutated onto a low frequency subcarrier oscillator. The commutator, described in a later paragraph, incorporated sixteen segments and each segment was sampled for two seconds. This sample time was chosen to permit the commutator output to be read on a simple voltmeter, the two seconds giving enough time for the monitor voltage to settle out and be observed before the commutator would move to the next segment. The monitors for each deck were:

a) High voltage on the detectors.
b) +13 volt internal power supply.
c) -13 volt internal power supply.

The instrument operated from a 28 volt (nominal) Nicad 24 cell battery with a one ampere-hour capacity located external to the instrument. The battery voltage was also monitored and commutated.

All the integrated circuit logic was of the complementary symmetry, metal oxide semiconductor (COS/MOS) type.

2.2 Physical Configuration

Each electronics system was made up of three sections: Four analog pulse amplifiers located on the channel-electron-multiplier assemblies on the moving carriage, three digital-logic cards located in a box at the rear of the instrument housing, and high voltage assemblies board located on top of the housing. Dual (+13V, -13V) low voltage regulated power supplies were mounted on the digital-logic cards. Hence, all electronics were internal to the housing and shielded from receiving or producing external radio frequency interference. The card box was also shielded from the detectors and vented directly to the outside of the housing away from the instrument entrance aperture. The instrument electrical interface connectors were hard mounted to the housing.

2.3 Circuit Description

A Block Diagram of the instrument electronics is given in Figure 2.

Each detector amplifier was used to feed pulses to a separate photon counter (consisting of four decade counters) on a single counter card. The binary-coded-decimal output from the counters representing the number of photons collected by the detector in 83.3 milliseconds weas transferred to the 16 bit shift register and shifted out as words three through six to the PCM output line during the following frame.

A modification of the accummulation time of the two shortest wavelength detectors in the lower deck was made, changing the time from 83.3 milliseconds to 33.3 milliseconds. This prevents overfilling the counters on 284 Å and 630 Å, which are wavelengths at which the sun's radiation intensity has increased greatly since the instrument was designed.

The wavelength-scanner position was counted in four decade counters on the motor drive readout cards, transferred to a 16 bit shift register, and shifted out as word two.

The sync word (1110101011001011) was generated on the timer card and was shifted out as word one of the PCM frame.

The six PCM words were combined, and processed on the PS/test/output card to give a nominal 5 volt signal to the FM/FM telemetry deck. This card also contained a test oscillator which, when enabled by the GSE console, generated 25,000 pulses/second to check the operation of the pulse amplifiers and counters. A DC-to-DC regulated power supply, also on this card, changed the battery 28 volts to +13 vots and -13 volts needed by the pulse amplifiers and integrated circuits.

The logic circuits for driving the four-position stepping motor were included with the scanner position circuits on the motor drive/timer card.

The timer card contained, in addition to the sync word generator, the PCM clock oscillator and logic circuits to generate the necessary sync pulses, shift pulses, load, inhibit, and counter reset signals. The clock oscillator was crystal controlled to .01 percent in frequency.

As shown in the timing diagram, the transfer and reset counter signals occur during the first half of the first word of the PCM frame. The photon counters were inhibited during the whole first word and thus accummulated counts during five-sixths of the frame or 83.3 milliseconds, except for the two counters which accummulated counts during two-sixths of the frame or 33.3 milliseconds.

The high voltage power supply operated from the 28 volt battery and produced 3000 volts. The output voltage was filtered and applied to the anodes of the four detectors. A resistor divider was used to supply 400 volts to the throat terminals of the detectors. Also, a tap at approximately 4 volts was used for a voltage monitor.

2.4 Commutator

The commutator combined onto one channel the monitor voltages of both instruments and the instrument battery.

The commutated signal was transmitted on subcarrier IRIG channel 10. The commutator operates directly from the instrument battery and performs correctly if the battery voltage is more than 18 volts.

3. FIELD SERVICE

3.1 Integration at Ball Aero-Space Division (BASD)

The Double Deck Spectrometer, with the mounted Electron Spectrometer, was checked electrically with the consoles on the bench at BASD, Boulder, Colorado April 23, 1979.

The Spectrometers were mounted on the pointing control pedestal April 24, and operated correctly through the rocket wiring.

An operation check was run using the system timer, sun gun, and telemetry to the local ground station. Operation was satisfactory, with no interference between experiments or from the pointing control. The photometer electronics was also operating in its own extension can, and operated correctly with no interference.

The remainder of the photometer extension can wiring was done on April 25 and April 26. The door squibs were fired during a separate photometer test. The photometer can was mounted on the shake table and operated in the launch mode during a "random" shake in the thrust axis with no failure.

Personnel returned to Boston on Friday, April 27, with the instruments and consoles.

3.2 Launch At White Sands Missile Range, New Mexico

Robert Hills of Tri-Con Associates, Inc. provided engineering field service for launch of the electronics sub-system of the EUV Spectrometer at White Sands Launch Complex 36. Eight days of work were required. A detailed report of the field trip was written and attached to Quarterly Status Report No. 11.

Since that report was written a closer look has been taken at the data. Robert Hills made strip chart records by playing the flight tape back through the console and a brush recorder. The electronics operated correctly throughout the flight. However, three of the eight channel electron multiplier detectors had a problem, possibly due to insufficient pumpout time. The rocket apogee was lower than predicted and the atmospheric density higher than during previous launches, but sufficient data were collected to achieve the objectives of the mission.

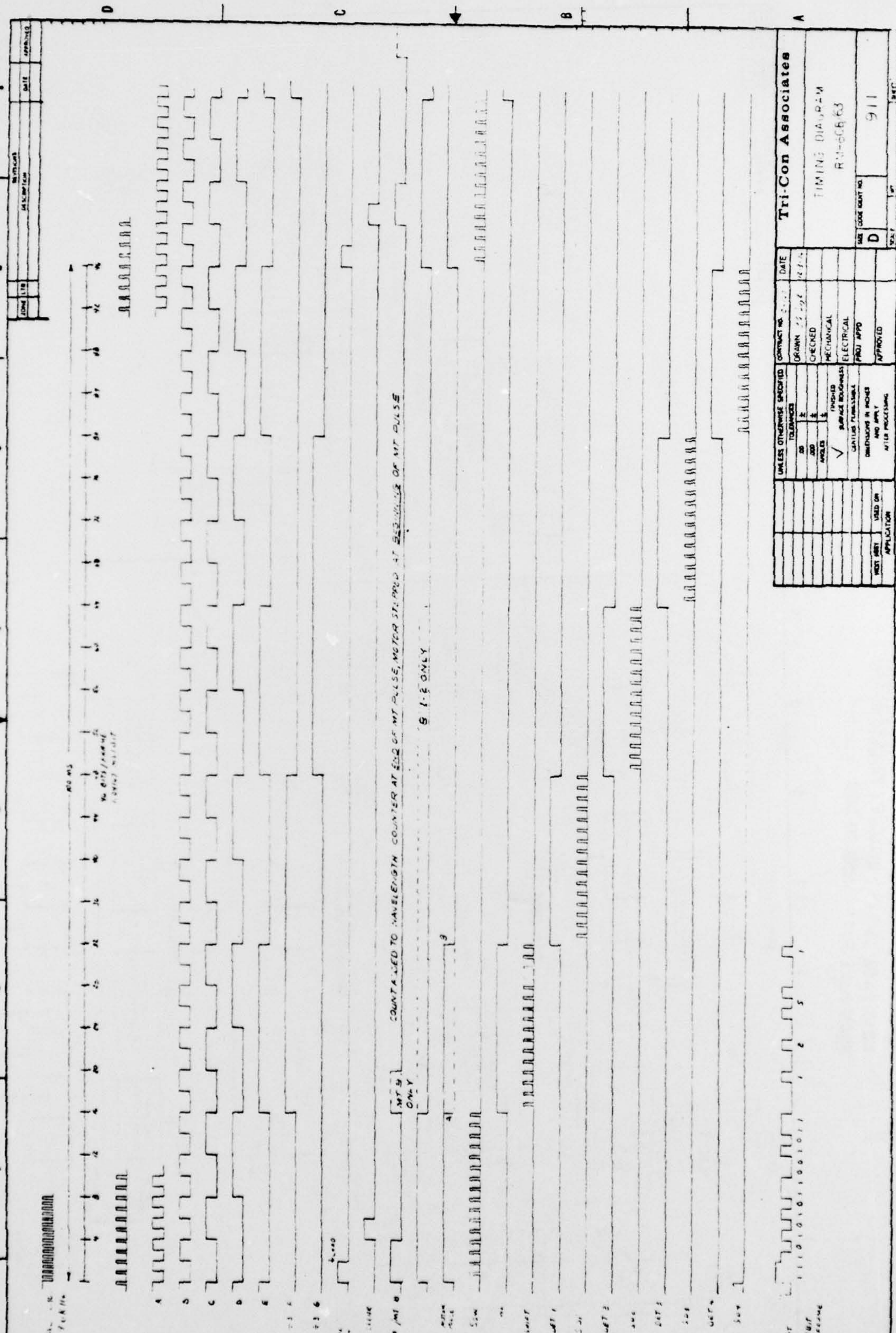

FIGURE 1

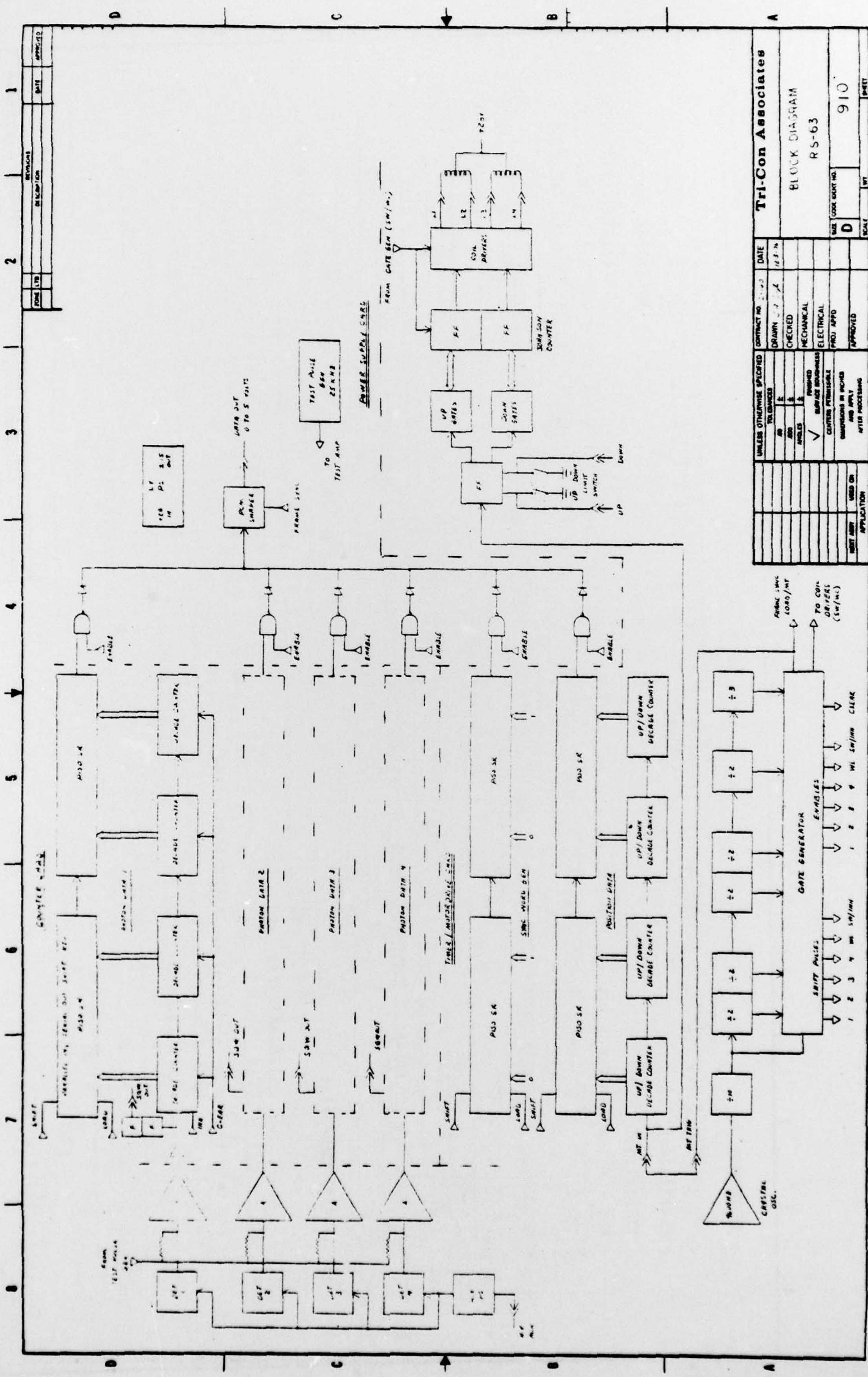
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FIGURE 2